by the rotor blades I have concluded that the linear spacing between the stator and rotor should be at least twice the dimension of the width of a single rotor blade. This will afford an additional increment of noise reduction to those previously described. The relatively few stator vanes specified by this invention also tend to be more compatible with other techniques of reducing stator noise, such as sweep, lean or nonuniform spacing of the stator vanes.

SUMMARY OF THE INVENTION

An object of this invention is to provide an improved propulsor characterized by its effectiveness of abating noise at the source.

A still further obect of this invention is to provide a prop-fan of the type described where the fan operates in the range of between 1.05 to less than 1.30 pressure ratio and less than sonic tip speed.

A still further object of this invention is a prop-fan having a multi-bladed fan and a multi-vaned aft stator where the number of vanes is substantially less than the number of blades and that the stator is axially spaced at least 2 rotor blade widths behind the rotor.

Other features and advantages will be apparent from the specification and claims and from the accompanying drawings which illustrate an embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a chart showing test data illustration of the noise spectra comparing the present invention with a prior art propulsor.

FIG. **2** is a view partly in perspective, section and schematic of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference is now made to FIG. **2** illustrating a prop-fan generally illustrated by reference number **10** exemplifying the preferred embodiment of this invention. Inasmuch as the invention is primarily concerned with the abatement of noise in propulsors, the particular construction details are omitted herefrom for the sake of clarity and simplicity. It is to be understood that the particular manner in which the prop-fan is mounted to the engine and the means for effectuating pitch change movement are all principles well established in the art and need not be shown here. While the prop-fan **10** is shown to be attached to bulkhead **12** and driven by shaft **14** of gas turbine engine generally illustrated by numeral **16**, it should be understood that the particular means of attachment and drive can take any other well known form. As for example, the prop-fan can be made integral with turbine power plant and either be driven by the compressor or turbine, directly ahead of the compressor or spaced therefrom as in a cross shafted assembly.

As is apparent from FIG. **2** the fan blades are mounted in and supported to a hub (not shown) about the fan rotating axis **20** within the bypass duct **22** for effectuating propulsive energy. Depending on the installation, the pitch of the fan blades may be fixed, or varied through a range of positive, negative and feathered positions in any suitable manner.

Bypass duct **22** extends beyond the engine inlet **24** so that a major portion of the air discharging from the fan is directed to bypass the engine while the relatively small remaining portion is ingested into the engine. Stators or turning vanes **26** axially spaced behind the fan are sandwiched between the inner diameter of the duct and the engine cowl **28** and serves to straighten the swirling air discharging from the fan and to support the annular duct **22.**

In accordance with this invention the noise generated by the rotor and anti-swirl vanes is abated at its source, rather than employing additives intended to suppress or absorb the noise energy. To this end the prop-fan is made to operate at a tip speed that is less than sonic and within a pressure range of between 1.05 and less than 1.3. Additionally the number of stator vanes should be less than the number of fan blades and preferably the count should be substantially 1:2 and the axial spacing between the rotor and stator should be 2 rotor blades widths.

It is of paramount importance that the fundamental blade passage frequency and its predominant multiples fall below the maximum annoyance band, the range of 2,500 to 5,500 Hertz as shown in FIG. **1.** As can be seen in the case of a turbofan, although the fundamental blade passage frequency and its multiples tend to fall beyond the maximum annoyance range there is a large amount of broad band noise energy, which is also rotor dominated, which falls in this maximum annoyance range. It is therefore an important aspect of this invention to select the operating parameters, namely tip speed and fan pressure ratios, so that the predominant acoustic modes of the prop-fan fall below the maximum annoyance band or at a frequency that is less than 2,500 Hertz and that the broad band noise energy in the maximum annoyance band is at a substantially low level.

It will be appreciated that FIG. **1** is a representation of actual test results of prop-fans and turbofans. Prop-fans designed to and operated in the following configurations resulted in perceived noise levels that were substantially 15 to 20 PNdb (perceived noise decibels) lower than conventional turbofans.

Fan Pressure Ratio	1.05 to 1.30
Number of Fan Blades	6 to 13
Fan Tip Speeds	600 to 800 ft/sec.
Rotor/Stator Spacing	Greater than 2 rotor blade widths
Number of Stator Vanes	3 to 7

Despite the remarkable abatement of noise at the source attainable through the use of the principles of this invention, the demand for minimum fan noise generation has become so stringent for many applications, such as VTOL and STOL aircraft, that some added sound absorptive treatment of the prop-fan shroud may also be required. However, at the much suppressed source noise levels of the prop-fan, the amount of absorptive material and the length of shroud required are much less than for the noisier, high-pressure-ratio, high-tip-speed fans of the prior art. This means less weight and less aerodynamic drag in cruise.

While this invention is described in its preferred embodiment as a means to obtain quiet aircraft propulsion, it will be obvious to one ordinarily skilled in the art that it has particular utility to other areas of usage where low noise and high performance fans are required, as for example, but by no means as limitations, lift fans for V/STOL aircraft, propulsion and lift fans for high speed trains and hovercraft, and ventilating fans.